Poster II-33

Imaging of Utah Electrode Array, Implanted in Cochlear Nerve

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In spite of its outstanding success in some profoundly deaf individuals, cochlear implants are not effective in all implanted subjects. Problems of limited low frequency restoration, limited numbers of channels, and high stimulation threshold currents are a result of the stimulating electrodes being located some distance away from the cochlear nerve, with the modiolar bone intervening between the electrodes and the nerve. An array of penetrating electrodes, inserted directly into the auditory nerve may mitigate some of these problems. The active tips of the implanted electrodes abutting the cochlear nerve fibers should allow much more focal stimulation than can be achieved via present cochlear electrode arrays.

We have implanted the Utah Electrode Array (see figure on left) into the cochlear nerve of felines for periods of over six months and have used high resolution CT imaging of the cat's head to verify the location of the electrode array in the cochlear nerve. The imaging was accomplished with a GE EVS-RS9 small animal computed tomography (CT) scanner producing a 131 Mb volume. There are distinct CT values for air, soft tissue, bone, and the electrode array, enabling the use of a combination of ray-tracing and volume rendering to visualize the array in the context of the surrounding structures, specifically the bone surface. Ray-tracing is a method commonly used in computer graphics that supports highly efficient implementations on multiple processors for interactive visualization. Visualization results were improved by smoothing the voxels outside the electrode array in order to better distinguish the boney structures.

As seen in the right-hand figure, the 27 micron resolution of the CT scan allows definition of the cochlea, the modiolus (on the right), the implanted electrode array, and the lead wires (in purple) that connect the array to a head mounted connector. The resolution of the scan even allows definition of the shanks and tips of the implanted electrode array. Volume rendering also allows the bone to be rendered as translucent, as on the left half of this image, enabling the electrode to be clearly viewed. Thus, the combination of high-resolution scanning, image processing, and interactive visualization tools such as ray-tracing, allows non-invasive verification of the implantation site in an anatomical structure that is completely encased in the thick temporal bone.

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